BANANA GRADING SYSTEM USING COLOR HISTOGRAM (BGS)

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Abstract

Bananas Grading System (BGS) which is one of the system using image processing technique. The purpose of BGS is used to standardize the grading of the banana and distinguish between three differences classes of banana which are unripe, ripe and overripe. This BGS used computer system to analyze and interprets images that correspondent to human eye and mind. This study is taken into account of four types of banana fruits which are 'Pisang Lemak Manis', 'Pisang Mas', 'Pisang Putar' and 'Pisang Berangan'. It attempts to form the decision by analysing the skin colour and condition. Bananas Grading System (BGS) is been done manually which brings variation of the results for banana grading. Since the colour is one of the most significant criteria related to fruit identification and fruit quality, it is a good indicator for ripeness. Therefore, fruits grading in present study only considers the colour of the skin of the bananas. The method that is used to develop this BGS is image processing method in term of color histogram of RGB. The color histogram method is evaluating the mean value of red, green and blue in order to classify the banana. In this BGS, fifty sample of banana is tested. From the result, the successful rate of grading the banana is 85% percent while the error rate is 15% percent. , based on the objective of this system which is to develop grading system to judge the maturity level and to standardize the banana grading based on maturity level, the objective is successfully achieved the goal. The problem regarding grading system by using Human Visualization System also solved. The cost of manual grading system, the time for grading the bananas and the man power uses is decreased.

Abstrak

Sistem Penggredan Pisang (BGS) yang merupakan salah satu sistem yang menggunakan teknik pemprosesan imej. Tujuan BGS digunakan untuk menyeragamkan gred pisang dan membezakan antara tiga perbezaan kelas pisang yang tidak masak, masak dan terlalu masak. BGS menggunakan sistem komputer untuk menganalisis dan mentafsir imej bahawa koresponden dengan mata dan minda manusia. Kajian ini diambil kira empat jenis buah-buahan pisang yang 'Pisang Lemak Manis', 'Pisang Mas', 'Pisang Putar' dan 'Pisang Berangan'. Ia cuba untuk membentuk keputusan dengan menganalisis warna kulit dan keadaan. Sistem Penggredan Pisang (BGS) dilakukan secara manual yang membawa perubahan keputusan untuk penggredan pisang. Sejak warna merupakan salah satu kriteria yang paling penting yang berkaitan kepada pengenalan buah-buahan dan kualiti buah, ia adalah petunjuk baik untuk perihal masaknya. Oleh itu, buah-buahan menggred dalam kajian sekarang hanya menganggap warna kulit pisang. Kaedah yang digunakan untuk membangunkan bgs ini adalah imej kaedah pemprosesan dalam sebutan histogram warna RGB. Kaedah warna histogram menilai nilai purata merah, hijau dan biru untuk mengklasifikasikan pisang. Dalam BGS ini, lima puluh sampel pisang diuji. Daripada keputusan kajian ini, kadar kejayaan menggred pisang adalah lima puluh peratus manakala kadar ralat adalah lima belas peratus. Berdasarkan objektif sistem ini adalah untuk membangunkan sistem penggredan untuk menilai tahap kematangan dan untuk menyeragamkan gred pisang berdasarkan tahap kematangan, objektif berjaya mencapai matlamat. Masalah mengenai sistem penggredan dengan menggunakan Sistem Visualisasi Manusia juga diselesaikan. Kos sistem penggredan manual, masa untuk menggred pisang dan penggunaan tenaga kerja dikurangkan.

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LIST OF ABBRIEVIATION

BGS	Banana Grading System
HSV	Human Visualization System
RGB	Red, Green, Blue
JPEG	Joint Photographic Experts Group
CCD	Charged Coupled Device
RAD	Rapid Application Development
CASE	Computer Aided Software Engineering
JAD	Joint Application Design
BIOS	Basic Input Output System

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

The agriculture industry is one of the industries that bring the economic development. This agriculture deals with the groups of crops, herbs, plants, and fruits. This agriculture plays a significant role in economic development. The fruit and crops further classify into more fruits such as banana, watermelon, strawberry, etc. according to their shape, colours and size. From the available groups of fruits, this thesis takes into account of bananas fruits only. There are many types of banana that can be study such as ‘Pisang Putar’, ‘Pisang Mas’, ‘Pisang Abu’, etc.

This study is taken into account of four types of banana fruits which are ‘Pisang Lemak Manis’, ‘Pisang Mas’, ‘Pisang Putar’ and ‘Pisang Berangan’. It attempts to form the decision by analysing the skin colour and condition. Presently, the skin condition and skin colour of bananas are observed by using human visualization system (HVS). The HVS possesses an extraordinary capability to meticulously investigate things. This mode of examination is regarded as the gold standard for drawing comparison. Though this is an appreciated way of examination but at the same time it is also responsible in bringing out variable judgments.

Bananas Grading System (BGS) is been done manually which brings variation of the results for banana grading. Consequently, bananas which do not consumable is supplied to the market. To address this gap, there is need for some well-established automated system that has ability to control this variation.

These variations are creating pressing demands to arrange some automatic system that can efficiently and effectively address these problems. Consequently, the desired system is expected to provide more stable and reliable results. The proposed method is expected to introduce standardization of the grading the bananas. The standardization means bringing maximum possible reduction of variation of result.

The proposed system is expected to utilize the shape, colour and size of bananas for grading. The skin colour and skin condition provide helpful information to estimate the maturity and the quality of fruits. Since the colour is one of the most significant criteria related to fruit identification and fruit quality, it is a good indicator for ripeness. Therefore, fruits grading in present study only considers the colour of the skin of the bananas. This proposed fruits grading system works in three steps which are the image acquisition, image pre-processing (e.g.: noise removal) and colour identification[1].

The employment of image processing technique is expected to significantly contribute in agriculture industry. Through this technique, the challenging job of standardization is likely to be achieved. Along with standardization of the automated system is expected to bring economic prosperity, times and resource optimization[9].

1.1 PROBLEM BACKGROUND

Banana is one of the popular fruits among Malaysian. Malaysian usually eat it as fruits, as dessert, chips or eat when hi- tea time. As a result of which bananas market is growing in Malaysia day by day. For supplying this, careful grading of this commodity should be done. The bananas that have been sent to the supermarket, market, entrepreneur chips or fruit store has been graded into a few grade. Generally, the suppliers do manual grading by observing the skin condition and skin colours of the bananas. But, unfortunately this mode of making decision requires considerably large amount of time, more man power and higher cost.

In order to make this grading system time efficient, a computer based system is need of the hour. The introduction of this automated system will not only reduce the time required to observe and investigate the fruits but will also optimize the economic

requirement needed in some business [9]. In term of economic requirement is where the suppliers of bananas will reduce the cost for hiring more peoples to observe the bananas and dividing the grade of bananas. Therefore, this research proceeded with the a few objectives that will be achieved.

1.2 PROBLEM STATEMENT

This study focuses for the introduction of standardization for investigating the bananas to be supplied to the market. The suppliers of banana usually use the human visualization grading system. Generally, the manual grading system is slow and it consuming the time. It will also increase the economic burden to the suppliers of banana in Malaysia. These economic burdens such as increase the cost of manual grading system, increase the time for grading the bananas and increase the man power uses.

The standardization of the bananas grade will be not achieved by using the human visualization grading system. This is due to the different consideration or observation of the skin condition of the bananas. So, it will bring the difficulties of suppliers of bananas in standardization of bananas grade.

1.3 OBJECTIVES

The objectives of this research of Bananas Grading System are:

1. To develop an automatic Banana Grading System to judge the maturity level in banana grading system for the supplying to the market.
2. To determine the appropriate algorithm in processing the banana and apply into the system.
3. To standardize the banana grading based on maturity level.

1.4 SCOPE

This study attempts to introduce a fully automatic banana grading system. The completion of the idea requires the digital camera with the calibration of the computer.

The usage of camera is to snap a few sample of banana image to be used in the proposed automatic banana grading system. While for computer usage is to store the image that has been taken by the camera. There are four types of banana has evaluate in this banana grading system which each type will have fifty sample from any level of ripeness that will be taken. The names of banana that has been evaluated are 'Pisang Lemak Manis', 'Pisang Mas', 'Pisang Putar' and 'Pisang Berangan'. Other than camera and computer, the software for reading the data from the camera and computer is needed. It is also to do some pre-processing process and post-processing process steps. The software needed is the MATLAB. This software is used to build the automatic banana grading system. The user of this proposed system is the supplier of banana to the market and entrepreneur of chips. Consequently, the understanding of some elementary statistic for the presentation and analysis of the result is needed. This proposed system is standalone system which is do not requires the internet. The example of statistic recently research and proposed system should be analysed and making a comparison between each other. The statistic of the grade of the banana should be known in order to do the automatic banana grading system.

1.5 THESIS ORGANIZATION

Thesis organization is explaining about the chapter that we need to cover in our thesis.

Chapter 2: takes into account the existing techniques employed for grading the fruits. This chapter presents the critical review of the existing grading matrix by focusing their strength and weakness. Finally the chapter decides about the selection of one specific method that needs to be researched upon.

Chapter 3: It will address the methodology used in this thesis. It gives block schematic description of the proposed methodology. It also provides detail about the database to be used for completing this study.

Chapter 4: This chapter contains the implementation detail and describes the project implementation of the system of whole development of system are needed to implement.

Chapter 5: Discuss the result produced by the proposed methodology and discussion that are obtained from the data analysis, project constraint and future work suggestion. In project constraint, there are two parts that has been divided. There are development constraints and system constrain. The development constraint divided into four types which is the constructed system, the representational relationship, the nature of system and the process of construction.

Chapter 6: this chapter provides the conclusion of this study. It suggests the future direction in the light of the weaknesses observed in proposed methodology.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

In literature review chapter, some existing method and algorithm from the expert system in their research need exploration and study. Some method and algorithm of grading system can be explored and making a survey of the usage of algorithm and method in order to be implemented in the proposed grading system.

Generally, the appearance of fruits is one of the important things to discover the quality and maturity of fruits. It can be determined by skin condition and skin colour of the fruits and can be classifying the fruits according to the groups and can be categorized by the parameters that need to be evaluated in grading the fruits[9]. The parameters of the grading fruits such as skin colour and skin condition should be observed to prevent the inaccuracy of the quality and maturity[2].

The fruits grading system is use for grading and ranking the fruits according to the category and group. It is important to differentiate the grading of fruits in the different categories in order to grading it into the correct group. For example, papaya in local grading standard should be classified into a certain group such as ripe, raw and overripe[11]. Papaya that been grouped into level of ripeness should be with the orange skin colour of fruits with no deficiencies[3]. Then the papaya that been classified into group raw should be with the green skin colour of fruits with limited deficiencies. While the papaya that classify into group of overripe should be with the skin colour of brown which have much deficiencies. So, by differentiate these level of ripeness, the fruits will be place into a correct categories.

Generally, this fruits grading system not only considered one parameter which is the colour of grading the fruits. It is also deliberate for those who industrialized discrete correlation between other parameters such as overall quality and shape[4]. These are fundamentally used for classification and standardization of the fruits grading.

2.1 FRUITS GRADING SYSTEM

Fruits are having a few stages of growth. The stages of growing of the fruits can be measured depends on the shape, skin colour of the fruits and diameter of the fruits. The stages are important in order to know the maturity of the fruits. By knowing the maturity of the fruits, the usability of the fruits can be able to distinguish. For banana grading system, the maturity of the fruits can be determined depending on the skin colour of bananas. For the skin colour, the maturity can be differentiate between green colour, yellow colour, red colour and much colour that having in fruits. For the diameter, we can compare the size of fruits to determine the maturity same goes to the shape of fruits[4].

Nowadays, fruits grading system has been applied in many developing countries in order to replace the manual grading system. The fruits grading systems is more applicable and can standardize the fruits grading more accurate compare to manual grading system. The automated grading system is more advanced and commercial compared to manual grading system[6]. Generally, this automated grading system has been applied in agriculture industries to fulfil the needs in this industry. Consequently, it bring some advantages in grading the fruits because in this hour, it getting special interest for higher quality and graded fruits product as the demand in agriculture industries[5].

This automated grading system provides the accuracy, reliability and the consistency in the method and algorithm of implementation process in the standardization of grading the fruits. Automated grading system ensure that the grading of fruits having the standardization of each grade and the quality of fruits. Furthermore, it is also preferred to ensure the consistency of fruits quality and large volume handled.

Consequently, this automated grading system having the economic advantages and benefits in making the consumers sureness about the quality and grade of fruits.

2.2 CASE STUDY ON EXISTING SYSTEM

There are many existing system of automated grading system. But those existing system will not use the same method. There are many kinds of method and technique in various existing system. The technique that has been selected and practical depends on the appropriateness of parameters that used. The validation of the technique is must in order to make the suitability of technique chosen with the parameters. The study of existing system makes the differentiation of various techniques. The best technique will be found and will be used in order to implementing and developing the new automated grading system.

2.2.1 Automated Oil Palm Fruit Grading System using Artificial Intelligence

Z.May and M.H Amaran has been done this research[1]. According to them, this system is basically about the automated oil palm fruit grading system. The ripeness of the palm oil fruits is determined by this system. The determination of grading the ripeness of palm oil fruits has been done manually by the human visualization graders before the existences of automated oil palm grading system. This manually grading has different perspective and may vary from each other. So, the other ways of standardization of grading system is introduce the new automated grading system by using RGB color model and artificial intelligence logic. This new automated grading system is developing in order to distinguish between the three different classes of oil palm fruits which are underripe, ripe and overripe. the differences of color intensity with the color ripening index has been experimental in order to recognize the ripeness of the oil palm fruits[1].

2.2.2 Fruit Size Detecting and Grading System Based on Image Processing

According to the Hongshe dang, Jinguo Song and Qin Guo who are doing the research on this study says to improving the fruits quality and production efficiency, the

automated detection technology should be develop[2]. This automated detection technology is the process of detecting the fruits both internal and external quality without any defection. They also say that the quality of fruits shape, default, color and size nowadays can not only evaluated by using traditional method. The development of image processing technology can be more effective. The significant of develop this grading and detecting system it to reduce the cost and develop high speed grading system[2].

2.2.3 Development of *Jotrapha Curcas* Color Grading System for Ripeness Evaluation

Zulham Effendi, RizauddinRamli, Jaharah Abdul Ghani and ZahiraYaakob have been done this research[6]. Based on this research, this study in presented the automated grading system for *Jatropha curcsas* by using color histogram. *Jatropha curcsas*is planted widely for nut harvesting in biodiesel manufacturing. It gives the perspective value in biodiesel manufacturing because it categorized as non-edible oil and it not be threaten by food purposes that available nowadays. The quality of *Jatropha curcsas* depends on type and size of defect along with skin color and fruits size. This color histogram method has been develop to distinguish the level of ripeness depends on color intensity[6]. It analyzes the red, green and blue (RGB) color of *Jatropha curcsas*.

2.2.4 Shape Characteristics Analysis for Papaya Size Classification

This research is done by SlametRiyadi, Ashrani A. Abd. Rahni, Mohd. Marzuki Mustafa and AiniHussain[4]. This research system is about the grading the papaya size according to the shape of papaya. It discussed about the development of computer vision system for papaya size grading using shape characteristic analysis. In this system, the RGB images were converted to the binary images using automated thresholding depends on OTSU method. The shape characteristic that been analyzed are area, mean diameter and perimeter that extract from papaya images[4]. Then the classification of the papaya will depend on the characteristic that had been analyzed.

2.3 TECHNIQUES/METHOD/ EQUIPMENT/ TECHNOLOGY USED IN EXISTING SYSTEM

Technique, according to the dictionary is the skill or practical method that has been applied in particular task. Technique is one of the important thing to been applied on system. Without technique, the system cannot be handled. In this research of existing system, there are a few different techniques that have been used in different system. While method, according to the dictionary is define as way of procedure to accomplish something in a system. Method is also one of the important things to use in system.

2.3.1 Automated Oil Palm Fruit Grading System using Artificial Intelligence

In this system, the technique that has been applied is artificial intelligence of fuzzy logic. This system is developing using fuzzy logic and RGB color mode[1]l. There are a method is use in order to accomplished this system. The method is divided into four phases which are image acquisition, background removal, color feature extraction and grading.

a. Image Acquisition

In this phase, the palm oil is collected from the plantation. Then, the palm oil is stored on the laboratory that has been controlled by the lighting to undergo the capturing images. Total seventy five samples of images were taken. All images were converted to the JPEG format with 640x480 pixel dimension. This phase is all about the capturing, formatting and resizing the images. The image capturing device is used to generate the images of sample. This images need to be converted and resized to prevent from any error during test the system. Generally, the technology of device used in machine vision is the solid state charged coupled device (CCD). This technology has been implementing of digital camera which needed the additional component for converting the images.

b. Background Removal

In this phase, the unnecessary background is removed and converted to black because it became the noises to the images (eg: Noise removal). The background subtraction method is used to remove the white background[1]. Figure 2.1 is shown an example of background removal process which is the white background is removed and converted to black.

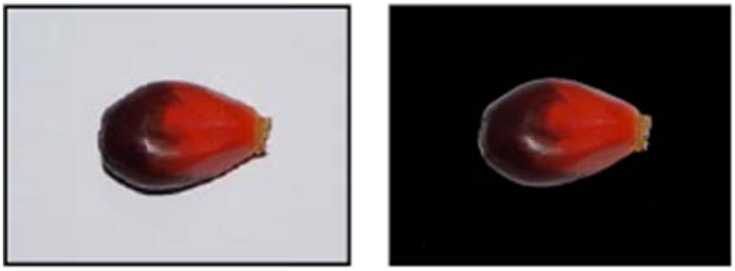

Figure 2.1 Background Removal of palm oil

c. Color Feature Extraction

In this phase, the color features are analyzed based on RGB color model. The color is classified into certain categories that are obtained a range of mean of value of red, green and blue layer. This ranges value are used as references of input of fuzzy logic system. There is also some calculation needed in order to find the range value of the color. In this color features, the number of pixel of the color and the mean value of color is most important things to know.

d. Grading

In grading phase, the fruits will be categories in certain level such as ripeness, shape or color. This phase is representing good approaches with the intention of interpret the decision making of process in the system. This phase is also making the standardization of some categories in the system.

The equipment is one the important things to have so as to complete the system. The equipment's that have been used in this research system are computer, CCD camera and MATLAB software. The CCD camera is used to evaluated and interpret image correspondent to the human eye and cognizance. The computer is used to develop a computer program for the image processing process like the calculation of color intensity and segmentation of color based on RGB color. The MATLAB software has been used to construct the fuzzy logic process in training the data and classification of the fruits and implementing the development of the system.

2.3.2 Fruit Size Detecting and Grading System Based on Image Processing

The technique that has been applied in this grading system is the image processing technique. In this system, the fruits are captured by side view images and the algorithm will extracted the characteristic of fruits. There is a method that been used in this grading system that are divided into five stages which are processing flow, image filter, edge detection, fruits size detecting algorithm and fruit size grading.

a. Processing Flow

The apple size is according to its diameter which is the longest distance in the apple's cross section. This detecting system is focused on calculating the diameter of apple. In this stage of method, it's explaining the grading flow of the fruits image size detecting. The detecting and grading flow is shown in Figure 2.2 below.